SAPROLITE ENVIRONMENTAL

31 March, 2014
Proposal No: PO-0187

ABM Resources NL
Level 1, 141 Broadway
Nedlands WA 6009

Attention: Justin Robins – Environmental Manager

Dear Justin:

Subject: Twin Bonanza Gold Project – Hydrogeological Works
Saprolite Scope Details

Further to our initial meeting on 19 February 2014, initial proposal dated 28 February 2014, recent meeting on 27 March 2014, and revised proposal of 31 March 2014, we are pleased to provide ABM Resources NL (ABM) with the details of our professional services as per the Scope of Works listed below for the purposes of submission to the regulators.

1. OBJECTIVES

The objectives serve to implement the proposed works as detailed in the Soil Water Consultant's Water Management Plan (WMP) (Dec 2013) that formed part of ABM's draft Environmental Impact Statement for the NT EPA. This includes:

- Drilling/Completion and Baseline Testing of 18 monitoring bores (nominal casing size 50mmND):
  - Three (3) analogue monitoring bores (A01 to A03)
  - Four (4) monitoring bores at Timmy's Bore (BF01 to BF04)
  - Four (4) monitoring bores in downgradient of site (M01 to M04)
  - Five (5) monitoring bores within site area (M05 to M09)
  - One (1) monitoring bore at Wilson's Bore (M10) to enable WL observations from the pumping bore.
  - One (1) monitoring bore at Corsair Bore (M11) to enable WL observations from the pumping bore.
- Drilling/Completion of a Replacement Production Bore at Timmy's Bore (pre-existing bore collapsed) for longer term water supply (nominal casing size 155mmND).
- Test Pumping Three (3) Production Bores:
  - Two (2) pre-existing and already equipped production bores (Wilson's Bore and Corsair Bore) to assess the existing pumping capacity.
  - One (1) replacement production bore at Timmy's Bore to assess the longer term water resource capacity.

2. SCOPE OF WORK

2.1 HYDROGEOLOGICAL WORKS

- Preliminaries and liaison with drilling contractor (contractor to be engaged directly by ABM to undertake the drilling). Includes:
  - Review drilling locations & bore depths, and brief assessment of geology
  - Preparation of technical drilling specifications and scope preparation

Saprolite Pty Ltd
ABN 43 135 590 724
PO Box 2234 Ellenbrook WA 6069
52B Mornington Parkway Ellenbrook WA 6069
Ph: (+61 8) 6296 7760 | Fax: (+61 8) 6296 7762 | Email: admin@saprolite.com.au

- Provision of necessary procedures, guidelines, forms and checklists for the collection of hydrogeological information and data for the supervision of water bore drilling.
- Provision of training by Saprolite's hydrogeologist during the site supervision of drilling works and bore construction comprising one replacement production bore at Timmy's Bore, and 1-2 monitor bores (time permitting; Saprolite hydrogeologist onsite for 6 days).
- Site supervision of drilling works and bore construction comprising remaining 16-18 monitoring bores at nominated locations and nominal depths would be undertaken by a nominated ABM geologist.
- Remote management/direction, support, troubleshooting during the drilling and completion of monitor bores, including progressive review of hydrogeological data collected, and feedback provided.
- Baseline testing of all completed bores, including field parameters, down hole (*in-situ*) EC profiling and water sampling/ laboratory analyses.
- Test Pumping of three (3) production bores
- Report preparation of a Bore Completion Report (ABM x 4 copies, Saprolite 1 x copy)

3. DRILLING AND BASELINE TESTING WORK PROGRAM

3.1 PRELIMINARIES

- Review drilling locations & bore depths, and brief assessment of geology, and finalise the proposed bore locations and depths to achieve the best outcomes with respect to the monitoring objectives of the WMP.
- Liaison with drilling contractor and client to establish drilling methods to be employed, and preparation of technical drilling specifications and scope preparation.
- Ongoing liaison with client and drilling contractor during the course of the project.

3.2 SITE WORKS

- Site safety management of the drilling contractor would be undertaken by ABM geological staff.
- Technical direction of the drilling scope of work, including initial full-time hydrogeological site supervision and training of ABM nominated geologist, and provision of necessary procedures, guidelines, forms and checklists for the collection of hydrogeological information and data for the supervision of monitor bore drilling. Saprolite would provide well-site supervision for drilling and completion of the production bore (4 days) and provide training to the ABM geologist during the drilling and completion of at least one or two monitor bores.
- The site supervision by ABM would include the collection of field measurements and observations during the drilling and bore construction, including, but not limited to:
    - Penetration rate log.
    - Lithological logging and descriptions.
    - Quality assurance of bore consumables: checking for defects in the casing, checking for compliance with technical specifications and soundness of materials.
    - Site specific bore design, determination of casing and bore consumables required, exact measurements of casing and bore consumables installed, maintaining records of as-built bore construction.
    - Hydrogeological field measurements during any air drilling and/or bore development including: airlift yield, water quality (EC/pH) and measurement of sand/silt content in the discharge water.
- Saprolite would provide the ABM geologist remote management/direction, support, and troubleshooting during the drilling and completion of monitor bores.

- On completion of each bore drilled and installed, or on a daily basis, the hydrogeological and geological data and information collected by the ABM geologist is to be forwarded to the Saprolite office for review. Feedback would be provided to ensure required information is collected, accurately recorded, with no omissions.

3.3 BASELINE TESTING

All completed and cased bores will be baseline tested onsite, including:

- Measurement of field water chemistry parameters, standing water levels and *insitu* EC profiling,
- Water sampling of the monitor bores, and water chemistry analyses by a suitable NATA certified analytical laboratory. The analytical laboratory would be engaged by ABM directly. The baseline testing would be undertaken during the test pumping work program (i.e. in-between tests). Should there be insufficient time to baseline test all holes within the 2 days allocated then the remainder of the monitor bores would be baseline tested concurrently during the test pumping program.

  NB Water sampling of production bores (3) would be undertaken as part of the test pumping works.

3.4 HYDROGEOLOGICAL REPORTING

- Presentation of all drilling results and water quality data, including but not limited to:
  - Well completion logs
  - Baseline testing results (EC profiles and water chemistry)
- Presentation of all test pumping results, including hydraulic analyses and estimation of aquifer parameters, and pumping capacities.
- Review SOP for Groundwater Monitoring, including analytical requirements, and monitoring equipment.
- Assess impacts on Groundwater Dependent Ecosystems, with respect to abstraction of groundwater from the production bores, notably from palaeochannel areas.
- Provide brief discussion of the hydrogeological works in the context of the objectives and the WMP, and include conclusions and recommendations.

4. TEST PUMPING WORK PROGRAM

4.1 GENERAL

- Test pumping will occur on:
  - Two (2) pre-existing, equipped and operational production bores (Wilson's Bore and Corsair Bore); both bores are understood to not have dip-tubes installed. It is recommended that dip-tubes are installed or provision is made to take water levels at the bore-well-head.
  - One (1) proposed new production bore to replace the collapsed bore, Timmy's Bore ("Strezza's"), this is assumed to be fully equipped and installed by ABM, as per the pumping specifications of the adjacent collapsed bore, including the installation of a dip tube for water level measurement.

4.2 INCLUDED WORK

Test pumping will be undertaken by Saprolite Wellsite Supervisors, under the direction of the Principal Consultant, whom has vast experience in conducting, managing, and supervising test pumping operations throughout WA.

4.2.1 Test Pumping

<u>Discharging the pumped water</u>

The water pumped from the bore should be prevented from returning to the aquifer, and recharging it. This can be done by conveying the water through a larger diameter pipe (or lay-flat) a distance of 100 to 200 metres.

In accordance with the WMP, there is to be zero discharge to the environment, and all discharge water is to be contained within pre-excavated sumps and evaporated.

The two equipped production bores, Wilson's and Corsair are fully reticulated with flow meters and pipelines back to the bulk sample water storage dam, as such the discharged test pumping water would not require containment. However, reticulated pipelines would impose an additional hydraulic head on the submersible pump, subject to the distance travelled of the pipeline, and over the change in elevation. This can affect the drawdown response and the pump capacity in being able to adequately stress the aquifer.

A suitably large containment sump/pond is likely to be required at Timmy's Bore; although should be at 100m distance from the pumping bore to prevent aquifer recharge.

ABM would be responsible for earthworks and excavation of containment ponds, and the provision of a suitable discharge line to the containment pond.

Installed Equipment

All production bores to be test pumped are to be fully equipped, powered and made operational prior to the mobilisation of Saprolite personnel for test pumping. It will be required that the installed equipment will need to be operated continuously once the step tests and constant rate tests are commenced. This in turn will require a continuous power supply, and if by portable generator, would need to have an automated fuel delivery system including fuel tanks. Refuelling and maintenance of the gensets would be the responsibility of ABM.

Wilson's and Corsair Bores are already equipped and are understood to be fully operational. The new replacement production bore at Timmy's Bore would be required to be fully equipped and installed using similar pump specifications as was installed in the pre-existing (collapsed) bore as guide. The pump specifications should be confirmed following the indicative yields obtained during the bore development upon bore drilling completion.

Details of the installed equipment, including pump specifications, and pump protection measures will be requested prior to mobilising to site for testing. These details, as well as inspection of the installations at Wilson's and Corsair Bores, can be undertaken whilst the Principal Consultant is onsite at the commencement of the drilling program.

Offline Status of Production Bores

We understand that Wilson's and Corsair Bores are operational water supply bores for the project, however, prior to respective test pumping, it is essential that each bore is rested for at least 1 week, to enable water levels to return to near ambient levels. We estimate that there may be a 5-7 day window where no water "should" be pumped from either bore in between testing the respective bores. Water storage capacities onsite will need to be investigated further, and careful management required. Further discussion/liaison will be required between Saprolite and ABM in terms of the testing schedule versus the water supply/demand requirements.

Bore Head-works

At the bore-head, the head-works should comprise the main items for test pumping - pressure gauge (for measuring back pressure on the pump), a dip-tube for measurement of water levels, a flow meter (for recording cumulative volume and instantaneous flow), a gate valve (for controlling the flow by inducing back pressure on the pump), a non-return valve (to prevent water syphoning back down the bore column, after the cessation of pumping), and a sampling tap. The existing bores (Wilson's and Corsair) have no dip-tubes installed and water levels may only be obtained from the proposed monitor bores to be drilled adjacent to within 3m of the production bores. The resultant data may only provide indicative results and not specifically from the pumping bore. It is recommended that dip-tubes are installed or provision be made at the headworks for water levels to be measured.

Conducting Pumping Tests

Pumping tests will not produce accurate data unless the tests are carried out methodically, carefully recording the time, discharge, and depth measurements. The pumping test to be carried out is as follows:

- *Multi-rate step tests*: to determine bore characteristics (where water levels can be measured), and optimum pumping rates for the constant rate test. The test is to comprise 4 equal steps of 100 minutes duration, with increasing rates of discharge (i.e. 1, 2, 3, 4 L/s, or 2, 3, 4, 5 L/s, or 3, 6, 9, 12 L/s etc). Measurements of water levels and discharge at given times are only obtained from the pumping bore.
- *Constant rate tests:* to determine hydraulic parameters of the aquifer, and estimates of bore/aquifer capacities (where possible), and forecast pumping yields. The constant rate test will be undertaken after a period of recovery from the step test. The test will comprise the bore being pumped at a constant rate for a period of nominally 48 hours. Measurements of water levels and discharge at given times are obtained from the pumping bore (where water level measurements are possible) and observation bores.
- *Recovery tests:* to determine hydraulic parameters of the aquifer. The test comprises water level measurements taken from the pumped bore (where possible) (and if possible from observation bores) from the moment the pump is turned off at the completion of the constant rate test. The period of the test will be up to 12 hours depending on the rate of recovery. The recovery test can be stopped sooner than 12 hours if the water levels in the pumped bore (or observation bore) reaches 95% recovery.

Preliminary Test

Preliminary steps should be taken to assure the reliability of pumping test data recorded during the actual test. For instance, given the pump is installed correctly, and bore head-works are already in place, the pump should be pumped for an hour or so (after measuring the pre-test water level (where possible)) for the following reasons:

- Ensure correct operation of the power unit, and that it had been fully serviced before any test pumping;
- The best method to measure yield;
- It is assumed the installed flow meters are appropriately calibrated to a ± 5% accuracy;
- Check the range of flow rates that are available by opening the gate valve fully to obtain the maximum, and closing the valve (but not shutting it totally) to lower the flow rate, thus obtaining the minimum. Make some assessment of the impact on aquifer water levels as to avoid pumping the bore dry during the early part of the test.
- Set the gate valve to give the desired discharge rate for the first step of the Multi-rate test.

Prior planning and experimentation with equipment during preliminary testing can eliminate errors that may occur during the actual pumping test. Never begin the actual pumping test however, until the water level in the bore has returned or nearly returned to the pre-test static level. Usually 2-4 hours should suffice.

However, often the following can be achieved depending on what time of day the preliminary testing was carried out. For example, if the preliminary testing commenced at 0600 hours, and stopped at 0800 hours, then by 1200 hours a 400min Multi-rate step test could be started. The bore would then be left overnight and a Constant Rate test commenced in the morning, with the water levels having recovered overnight.

Comments

The accuracy of the data taken during the test pumping depends on the following:

- Maintaining a constant yield during the test or, in the case of step tests, during the particular step.
- Measuring the water levels carefully in the pumping bore (where possible) and observation bores.
- Measuring the water levels at the appropriate time intervals.
- Continuing the test for the appropriate length of time.

Proposed Test Pumping at TBGP

It is proposed that three production bores be test pumped in the above manner for 48hr Constant Rate Tests. - That is:

- Preliminary Test
- Multi-rate Step Test
- Constant Rate Test
- Recovery Test

Nominal schedule of bores to be observed during testing:

Test Type	**Wilson's Bore (WB)**	**Corsair's Bore (CB)**	**Replacement Timmy's Bore (TB-A)**
Preliminary	Pumping Bore (WB)	Pumping Bore (CB)	Pumping Bore (TB-A)
Step Test	Pumping Bore (WB)	Pumping Bore (CB)	Pumping Bore (TB-A)
Constant Rate Test	Pumping Bore (WB) Monitor Bore (M10)	Pumping Bore (CB) Monitor Bores (M11)	Pumping Bore (TB-A) Monitor Bores (BF01, BF02, BF03, BF04)
Recovery Test	Pumping Bore (WB) Monitor Bore (M10)	Pumping Bore (CB) Monitor Bores (M11)	Pumping Bore (TB-A) Monitor Bores (BF01, BF02, BF03, BF04)

5. PROJECT TEAM

Garth Richards will assume the role of Project Director/Manager and Supervising Principal Consultant. Shaun Wimbridge will be Task Leader for the site works in its entirety as well as taking responsibility for the reporting. It is proposed that Shaun will kick off the project onsite with the supervision of the production bore drilling and completion, and onsite training of the nominated ABM geologist for 1-2 monitor bores; Shaun would be onsite for up to 6 days.

The baseline testing and test pumping will require two people (Shaun and Rob) for efficiency with the baseline testing, and for test pumping due to the continuous nature of the testing required. It is proposed that Garth will mobilise to site with the test pumping crew, and be onsite for 3 days overseeing the test pumping of the first bore.

6. TIMING AND SCHEDULING

It is estimated that the monitor bore drilling will take up to 20 days and the production bore 4 days. On completion of the last bore, the completed bores are rested for up to 14 days to allow water levels to stabilize, and then can be baseline tested thereafter. The baseline testing should be completed in 2 days. Test pumping of the production bores would take up to 4 days each test, totaling 12 days.

A nominal schedule of works upon award is as follows:

- Preliminaries - 1 week
- Awaiting approvals, site access – unknown
- Drilling works (monitoring bores) – 20 days in total but could be undertaken during the proposed mineral exploration program
- Water level stabilization – 2 weeks (after the completion of the last bore)
- Test Pumping – 12 days (say 2 weeks)
- Baseline Testing – 2 days
- Reporting (analysis, review, assessment, presentation of data) – 6 weeks post site work

We can start preliminary work within 1 to 2 days of the project being awarded and a purchase order provided.

We would be available to commence the site works within 2-3 weeks' notice, subject to

- any regulatory site approval being required
- drilling contractor availability
- existing Saprolite commitments (i.e. after 22 June 2014, as discussed at meeting 27 March 2014)

If you are agreeable to this proposal, we kindly request that a purchase order be forwarded to us so that we may schedule our resources.

We understand that regulatory approvals may not be provided for a month or two, but the works are anticipated to commence towards the end of the first half of 2014. This nominal timeframe fits in with Saprolite's availability, subject to sufficient notice being provided, and subject to other project commitments that arise between the date of this proposal and notification of award, should we be successful.

Should you have any queries in relation to the above or any other matter, or require clarification on any aspect please do not hesitate to contact the undersigned on ph (08) 6296 7760.

Yours faithfully

SAPROLITE ENVIRONMENTAL

Garth Richards
Senior Principal Consultant
Managing Director